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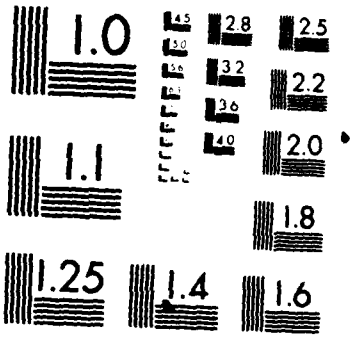

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SNOWY PLOVER (*Charadrius alexandrinus*)

Section 4.4.1, US ARMY CORPS OF ENGINEERS WILDLIFE RESOURCES MANAGEMENT MANUAL

by

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US ARMY ENGINEER WATERWAYS EXPERIMENT STATION

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A wildlife species account for the snowy plover (*Charadrius alexandrinus*) is provided as Section 4.4.1 of the US Army Corps of Engineers Wildlife Resources Management Manual. The account is developed as a guide to provide the Corps District or project biologist with basic information on the biology, ecology, and management of the snowy plover. Major topics covered include status, characters and measurements, population attributes, habitat requirements, management, and census and sampling.

The geographic range of the snowy plover is described, and the status of the species in North America is discussed. Diagnostic features and criteria for sex and age determination are given under the heading characters and measurements. The section on population attributes provides information on abundance, movements, breeding biology, and mortality. Ecological requirements are discussed, and components of breeding habitat are described for

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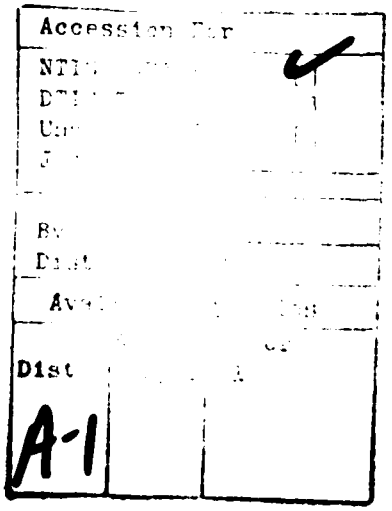
the West Coast and interior sites. Strategies for managing snowy plover habitat and controlling degradation of breeding sites are presented. The census and sampling section provides techniques for measuring habitat variables and estimating plover populations.



PREFACE

This work was sponsored by the Office, Chief of Engineers (OCE), US Army, as part of the Environmental Impact Research Program (EIRP), Work Unit 31631, entitled Management of Corps Lands for Wildlife Resource Improvement. The Technical Monitors for the study were Dr. John Bushman and Mr. Earl Eiker, OCE, and Mr. Dave Mathis, Water Resources Support Center.

This report was prepared by Ms. Ruth A. (Wilson) Jacobs, US Army Engineer District, Portland, Portland, Oreg., under an Interagency Agreement with the US Army Engineer Waterways Experiment Station (WES). Mr. Chester O. Martin, Team Leader, Wildlife Resources Team, Wetlands and Terrestrial Habitat Group (WTHG), Environmental Laboratory (EL), was principal investigator for the work unit. The following individuals are gratefully acknowledged for providing information on the biology and management of snowy plovers: Roger L. Boyd, Baker University, Baldwin City, Kans.; Stephen G. Herman, Evergreen State College, Olympia, Wash.; Charles A. Chase, Denver Museum of Natural History, Denver, Colo.; John C. Warriner and Jane S. Warriner, Watsonville, Calif.; Judith Wickham, US Bureau of Land Management, Coos Bay District Office, Coos Bay, Oreg.; Gary W. Page, Point Reyes Bird Observatory, Bolinas, Calif.; Lynn E. Stenzel, Point Reyes Bird Observatory, Bolinas, Calif.; and Jim Collins, Oregon Department of Fish and Wildlife, Roseburg, Oreg. Review and comments were also provided by Mr. Martin and Dr. Wilma A. Mitchell, WTHG, and Mr. E. Paul Peloquin, US Army Engineer Division, North Pacific, Portland, Oreg.

The report was prepared under the general supervision of Dr. Hanley K. Smith, Chief, WTHG, EL; Dr. Conrad J. Kirby, Chief, Environmental Resources Division, EL; and Dr. John Harrison, Chief, EL. Dr. Roger Saucier, WES, was Program Manager, EIRP. The report was edited by Ms. Jessica S. Ruff of the WES Information Products Division (IPD).

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NOTE TO READER

This report is designated as Section 4.4.1 in Chapter 4 -- WILDLIFE SPECIES ACCOUNTS, Part 4.4 -- SHORE AND WATER BIRDS, of the US ARMY CORPS OF ENGINEERS WILDLIFE RESOURCES MANAGEMENT MANUAL. Each section of the manual is published as a separate Technical Report but is designed for use as a unit of the manual. For best retrieval, this report should be filed according to section number within Chapter 4.

SNOWY PLOVER (*Charadrius alexandrinus*)

Section 4.4.1, US Army Corps of Engineers
Wildlife Resources Management Manual

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The snowy plover, or kentish plover of European authors, is a small shorebird belonging to the family Charadriidae. The species is distributed throughout much of the Eastern Hemisphere and in the Western Hemisphere in western and southern North America, in the West Indies, and along the western coast of South America (Rittinghaus 1975).

Rittinghaus (1961) recognized 12 subspecies of the snowy plover, 2 of which occur in North America (Fig. 1). The Cuban snowy plover (*C. a. tenuirostris*) breeds in Cuba and St. Croix and along the Gulf of Mexico from western Florida to Texas and northeastern Mexico, in interior regions of some of these states (e.g., Texas Panhandle, Oberholser 1974), and on islands off the Venezuelan coast (Palmer 1967). Although birds may remain year-round within their breeding range, some populations shift southward during the winter (Palmer 1967). The western snowy plover (*C. a. nivosus*) breeds along the Pacific coast from southern Washington into Baja California, and to the east through and including portions of the Great Plains (American Ornithologists' Union 1957). As presently defined, the western subspecies winters

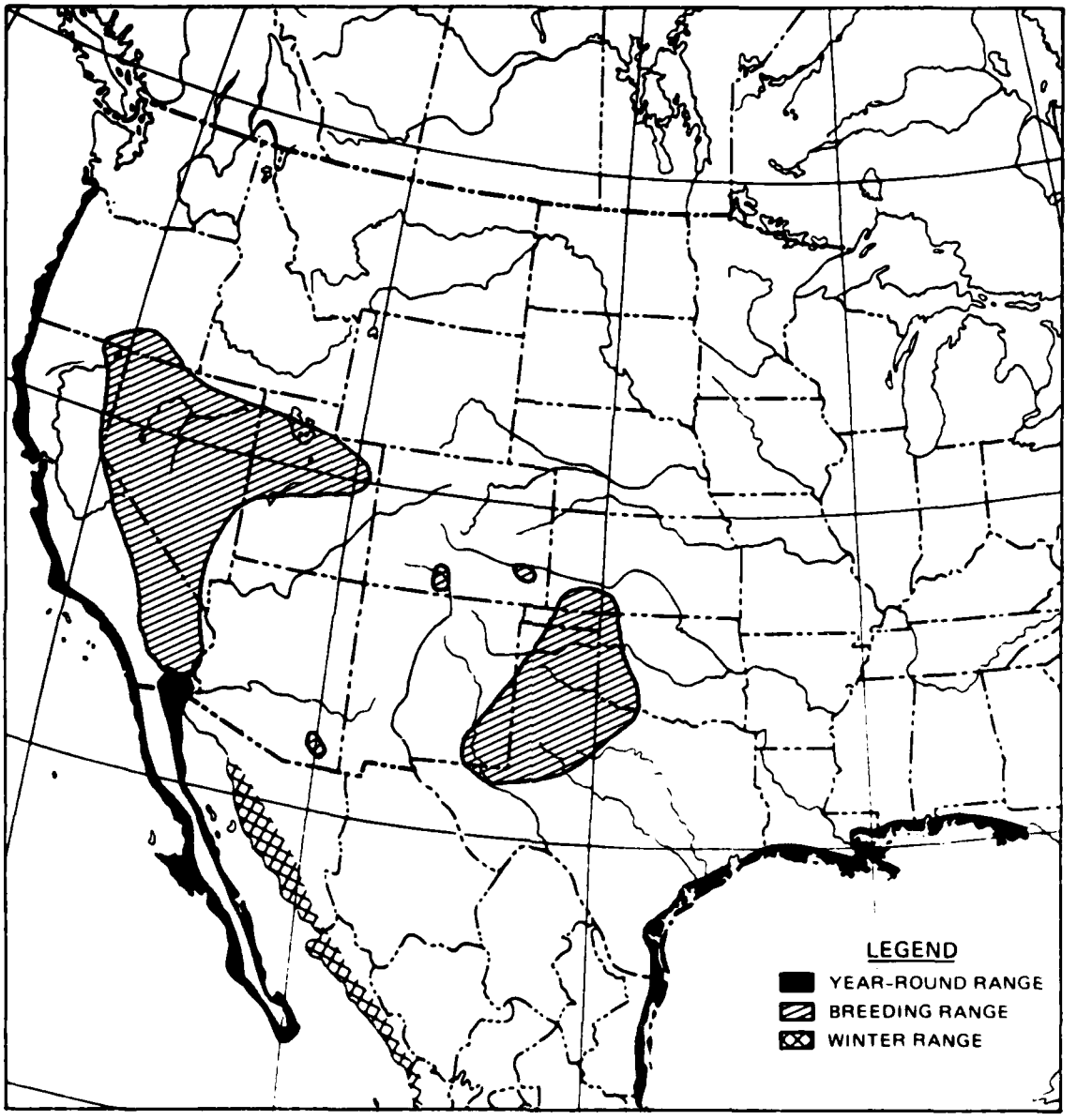

Figure 1. North American distribution of the snowy plover (*Charadrius alexandrinus*) (after National Geographic Society 1983)

along the Pacific coast south of Washington, at the Salton Sea in southern California and other southern locations within the United States, and in Baja California and on the west coast of mainland Mexico (Page et al. 1981). The subspecific status of populations breeding in the Great Plains is questionable as it is more likely that these birds would migrate to the Gulf coast and mix with *C. a. tenuirostris* rather than migrate to western regions of North America to winter with populations of *C. a. nivosus*. In fact, 2 birds banded in Kansas have recently been observed along the Texas coast in fall and winter months (Roger L. Boyd, Baker University, Baldwin City, Kansas, pers. commun.). However, for this account the present classification is accepted.

STATUS

The snowy plover is a nongame species protected by Federal law and international treaty under the Migratory Bird Treaty Act. Natural and man-made factors, including predation, adverse weather, recreational development, shoreline modification, urban and industrial development, and encroachment of vegetation in areas preferred by snowy plovers, pose potential threats to the species. The U.S. Fish and Wildlife Service Endangered Species Program recognized the vulnerable nature of snowy plovers and reviewed the status of the western subspecies in 1980 but did not deem it necessary to list the race as Threatened or Endangered at the Federal level. However, several states, agencies, and organizations have applied their own status designations for the species (Table 1).

CHARACTERS AND MEASUREMENTS

Description

The snowy plover is a small pale plover with an incomplete breast band that appears as a dark patch on either side of the upper breast. The crown and back are basically a pale sandy color, contrasting with white underparts. Adult birds may also have a dark forehead patch and dark patches behind the eyes. The bill is black, and the legs and feet are dusky gray. Total length ranges from 15 to 18 cm (Palmer 1967); wingspan is approximately 34 cm (Oberholser 1974).

Table 1. Status of the snowy plover by various states, agencies, and organizations

State, Agency, or Organization	Status	Citation
Alabama	Endangered	Keeler 1976
Mississippi	Rare	Jackson 1975
Oregon	Threatened	Oregon Dep. of Fish and Wildl. 1975
Washington	Endangered	Washington Dep. Game 1982
National Audubon Society	"Blue-Listed" (since 1971)	Arib 1971
U.S. Forest Service	Sensitive	USDA Forest Service 1981

The species is similar to the piping plover (*Charadrius melodus*) which is also small and pale but may have either a complete or incomplete dark ring around the neck. The legs of the piping plover are yellow, and the bill is yellow with a black tip. Winter and juvenile piping plovers may have dark legs and bills, but they have white rumps and lack the dark breast bands and eye patches of snowy plovers. (Refer to standard field guides for further comparisons of the species.)

Eggs are short, ovate, and without gloss. The ground color is olive-buff and randomly covered with small spots or scrawls of black and fewer spots of pallid gray. Egg size averages 32 by 23 mm (Boyd 1972).

Sex Determination

In breeding (nuptial) plumage (usually from March to August) males tend to have darker backs and blacker head and breast markings than females (Palmer 1967). Males of *C. a. nivosus* may also exhibit a rufous patch behind the dark forehead patch. The winter plumage (August to late February or March) of both males and females becomes duller than the nuptial plumage of females, and sexes cannot be distinguished in the field (Palmer 1967). Even in nuptial plumage, distinction of sexes is not always possible unless a mated pair is closely observed. Exceptions to these characters may occur within the species range.

Age Determination

Three age classes may be recognized: (1) flightless chicks, (2) juveniles, and (3) adults. However, it is difficult to separate juveniles and adults in the field after July because plumage characteristics are similar after the onset of postjuvenal and postnuptial molts.

A general account of plumage and molt patterns, after Bent (1929) and Palmer (1967), is provided as follows. Upper parts of natal plumage are pale buff mixed with grayish white. The crown, back, rump, wings, and thighs are distinctly and evenly spotted with black. Juvenile plumage for males and females differs from winter plumage in having pale margins on covert feathers, a virtual absence of dark forehead and eye patches, and a light (sometimes absent) patch on the side of the upper breast. Adults have a complete postnuptial molt in late summer and fall and a partial prenuptial molt in early spring.

POPULATION ATTRIBUTES

Abundance

Population estimates are incomplete for the snowy plover because many portions of the breeding and wintering ranges have not been surveyed. Based on available data, a conservative total of 6000 breeding birds may be projected for the species in North America.

Regional surveys. Information on abundance patterns is most available for the western subspecies during the breeding season. A cumulative total of 3409 breeding adults have been found in coastal and interior areas of California (Page and Stenzel 1981). More birds occur at interior than coastal areas, and the number of birds along the coast decreases from south to north. In Oregon a cumulative total of more than 1200 breeding adults have been found in coastal and interior areas (Wilson 1980; S. G. Herman, Evergreen State College, Olympia, Washington, unpubl. data) with over 80% of these birds in the interior. Survey teams in other western states have found 26 adults at 2 areas on the Washington coast (Widrig 1980) and 968 adults at 12 areas in western Nevada (S. G. Herman, unpubl. data). In portions of the Great Plains, estimates of abundance are 150 to 200 breeding adults in Kansas (Boyd 1981a); 400 to 650 birds at Great Salt Plains National Wildlife Refuge, Oklahoma (Grover 1979, Boyd 1981b); and up to 146 birds in Colorado (C. A. Chase, Denver Museum of National History, Denver, Colorado, pers. commun.).

Other recent records of snowy plovers in North America are in the form of sightings rather than systematic surveys. Jackson et al. (1980) reported snowy plovers on the Gulf Island National Seashore, Mississippi, at all months of the year and located 13 nests during a breeding season on Horn Island. Hays (1978) reported a nesting snowy plover on the mainland coast of Mississippi and cited records of observations on the coasts of Texas and Florida and on sand islands off the Alabama coast. Oberholser (1974) reported breeding birds to be fairly common to uncommon along the Texas coast from Galveston Bay to the mouth of the Rio Grande and uncommon and local in and near the Texas Panhandle. Portions of Utah, mainland Mexico, and Baja California probably support important breeding populations, but comprehensive survey data are lacking.

Density estimates. Low breeding densities have generally been reported for North American populations of the snowy plover. However, density estimates have only been determined for scattered locations within the species range. At Mono Lake, an alkaline area in east-central California, a density of approximately 0.09 pair/ha (0.04 pair/acre) occurred within a 990-ha (2445-acre) area that was considered optimal habitat for the region (Page et al. 1979). Along sandspits and estuarine margins of the California coast, Stenzel et al. (1981) reported densities of 0.1 to 5.7 pairs/ha (0.04 to 2.31 pairs/ac) of open area.

Relative abundance. Estimates of breeding populations of snowy plovers are commonly based on relative abundance because of difficulties in obtaining density data. For shorelines such as ocean beaches, numbers of pairs/kilometer or mile of shoreline surveyed are often reported. Using this measure, relative abundance on dune-backed or pocket beaches of California has been reported as 0.4 to 16.0 pairs/km (0.7 to 26.1 pairs/mile) (Stenzel et al. 1981). Relative abundance on the Oregon coast was determined as 0.2 pair/km (0.3 pair/mile) of beach surveyed (Wilson 1980).

Movements

Snowy plovers may be resident or migratory in coastal regions but are migratory inland north of Mexico. Movements of birds in Mexico have not been studied, but it is suspected that Baja and the west coast of mainland Mexico are important wintering areas for birds from more northern regions. Birds that breed on the Pacific coast of the United States may winter in the same

areas used for breeding or may shift to other areas along the coast (Warriner et al. 1986). Birds are capable of traveling over 700 km (434 miles) from coastal breeding areas to coastal wintering areas and more than 400 km (248 miles) from interior to coastal areas (Page et al. 1981). Assuming that some birds travel from the Great Basin to winter in Mexico, migrations of over 1600 km (1000 miles) are possible.

Movements also occur within breeding and wintering seasons. Breeding adults may move among areas to renest, or they may move after successfully hatching a nest (Warriner et al. 1986). Movements within a wintering season may be partially explained by loss or alteration of habitat due to inclement weather conditions.

Breeding Biology

The majority of information on the breeding biology of snowy plovers in North America pertains to studies of the western subspecies and serves as the basis for information presented in this section.

Breeding season. Snowy plovers breed from mid-March through September with regional variation depending on climatic conditions. In the Great Plains they may arrive at breeding areas as early as the first week of April. Although nesting may begin as early as late April, most nests are initiated between mid-June and early July and chicks may be present through August. Most birds migrate by late September (Boyd 1972). In the Great Basin at Mono Lake, California, snowy plovers begin to arrive on breeding grounds in early April, and nests are initiated from approximately mid-April to mid-July. Chicks from late nests fledge as late as mid-September, and birds are probably present until at least late October (Page et al. 1983). On the Pacific coast most nests are initiated from April through mid-July, but exceptionally early nests may be found in March (Wilson 1980, Warriner et al. 1986). Chicks can be present into mid-September. In the southeastern United States active nests are known from mid-April through early July (Hays 1978, Jackson et al. 1980).

Nesting. Snowy plovers may return repeatedly to breeding areas and may even nest in the exact site used the previous year (Warriner et al. 1986). The nest is a shallow scrape or depression lined sparsely with shell fragments and other debris. Males and females defend a territory around the nest site; size apparently varies with features of the habitat, individual preferences of birds, and stage of incubation. Pairs of simultaneously active nests as close

as 5 m (16.4 ft) are known (Boyd 1972). Page et al. (1983) stated that approximately 20 nests/6 ha was the maximum density reported for any site in California; this converts to 3.3 nests/ha (8.2/acre). When chicks are present, territories are best described as mobile and correspond to areas occupied by family groups.

Laying of eggs is complete within 4 to 5 days. Incubation generally begins after the last egg is laid and continues for approximately 27 days with both sexes sharing the duties (Boyd 1972, Warriner et al. 1986). Eggs may be visibly cracked as many as 4 days before hatching but may not be pipped earlier than 4 to 5 hours prior to hatching (Boyd 1972). The length of time between hatching of the first and last egg can be as long as 33 hours, but less time is more usual (Warriner et al. 1986). Chicks are precocial and can leave the nest as soon as dry, often within 1 to 2 hours of hatching (Boyd 1972). Chicks require about a month from hatching until fledging (Boyd 1972), during which time they are attended by one or both adults (Warriner et al. 1986).

Clutch size and number. The usual clutch size is 3 eggs (Boyd 1972); 4 or more eggs per clutch are rare. Snowy plovers may renest if eggs are destroyed or if broods are lost (Wilson 1980, Warriner et al. 1986). Double brooding has been observed in California (Warriner et al. 1986) and may also occur on the Oregon coast because only males accompany broods and females may pair with more than one male (R. W. Jacobs, unpubl. data). Rittinghaus (1975) reported some instances of double brooding for the kentish subspecies. Snowy plovers are reported to be monogamous and single brooded in Kansas (Boyd 1972) and on barrier islands off the Mississippi coast (Jackson et al. 1980). The short duration of the breeding season in the Great Plains may prohibit multiple broods.

Nest success. Measures of nest success (percent nests hatching at least 1 egg) from localities along the West Coast and Great Plains vary from 0% to 80% (Table 2). Low nest success is not the result of failure of eggs to hatch since reports of over 20% egg failure are unknown. Rather, complete clutches are lost due to (1) predation [known predators include California gulls (*Larus californicus*), common ravens (*Corvus corax*), common crows (*C. brachyrhynchos*, and raccoons (*Procyon lotor*)]; (2) adverse weather conditions, including storm tides, wind-driven sand, and hail or rainstorms; (3) trampling by cattle; and (4) human disturbance (Boyd 1972, Grover 1979, Wilson 1980, Page et al. 1983, Warriner et al. 1986).

Table 2. Estimates of snowy plover nest success*

Area	Year	Percent Success	No. Nests Observed	Reference
Mono Lake, Calif.	1978-1981	40-68	150+	Page et al. 1983
Pajaro River Mouth, Calif.	1977-1982	58	189	Warriner et al. 1986
Central Coast, Oreg.	1978-1979	13	72	Wilson 1980
New River Estuary, Oreg.	1981	0	13	J. Wickham, unpubl. data, BLM
Leadbetter Point, Wash.	1979-1980	60-80	10	Widrig 1980
Leadbetter Point, Wash.	1981	79	14	Saul 1982
Cheyenne Bottoms Wildl. Manage. Area, Kans.	1970-1971	55-59	47	Boyd 1972
Salt Plains Natl. Wildl. Refuge, Okla.	1977-1978	14-38	89	Grover 1979

* Nest success measured as percent nests hatching 1 or more eggs.

Reproductive success. Although nest loss can be severe at times, the only accurate reflection of success in breeding activities is reproductive success (the number of young fledged per female). Measurement of reproductive success is complicated by the following factors: (1) movements of adults to and from breeding areas during a breeding season; (2) the snowy plover's ability to readily renest and, in some cases, produce double broods; (3) small and therefore inconspicuous sizes of breeding populations at many areas; and (4) secretive habits of adults and broods during the fledging period. Individually marked adults and broods and regular, systematic surveys to determine numbers of males and females present throughout the breeding season are essential for accurate estimates of reproductive success. Estimates of reproductive success in North America vary from 0.1 to 2.0 young fledged per female (Table 3). Rittinghaus (1975) in Europe considered that 1.5 to 2.2 young fledged per female represented average breeding

Table 3. Estimates of snowy plover reproductive success* from the Western United States

Location	Year	No. of Females	Reproductive Success	Reference
Pajaro River Mouth, Calif.	1977-1982	13-26	0.3-2.0	Warriner et al. 1986
Mono Lake, Calif.	1978	81	0.5-0.7	Page et al. 1979
Central Coast, Oreg. (4 sites)	1978-1979	18	0.1-0.2	Wilson 1980
Leadbetter Point, Wash.	1978-1980	5-10	0.3-1.0	Widrig 1980
Leadbetter, Point, Wash.	1981	5-10	2.0	Saul 1982

* Reproductive success is the number of young fledged per female.

success for the kentish plover. Loss of chicks is rarely documented, but avian predation, inclement weather conditions, starvation, and human disturbance are commonly suggested lethal factors (Boyd 1972, Rittinghaus 1975, Grover 1979, Widrig 1980, Page et al. 1983, Warriner et al. 1986).

Breeding age and longevity. Snowy plovers are able to breed the year following hatching. They apparently are long lived compared to other small birds, as are most shorebirds (Boyd 1962). There are 5 records from Europe of kentish plovers at least 13 years of age (Rittinghaus 1975). In North America there is a record of a snowy plover recaptured 11 years after banding, and there are several records of birds at least 4 years old (Boyd 1981a).

Sex and age ratios. Male snowy plovers are more easily detected than females during the breeding season (Warriner et al. 1986), and relative proportions of males and females observed on surveys may not reflect general sex ratios. Warriner et al. (1986) calculated a male:female ratio of 1.40:1 at Mono Lake, California, during the 1981 and 1982 breeding seasons. Snowy plovers cannot be aged following the summer of the year they hatch except through banding programs. There has not been sufficient banding of snowy plovers in North America to adequately address age ratios.

Mortality

Boyd (1962) inferred from band recoveries and capture/recapture studies that annual adult mortality was 41%. More recent studies of banded birds on the California coast have revealed maximum mortality rates of 21% for adult males, 27% for adult females, and 36% for juveniles (Warriner et al. 1986; G. W. Page, Point Reyes Bird Observatory, Bolinas, California, unpubl. data). Instances of adult mortality due to avian predation (J. Collins, Oregon Department of Fish and Wildlife, Roseburg, Oregon, unpubl. data) and hailstorms (Grover 1979) are known.

HABITAT REQUIREMENTS

Habitat Components

Breeding habitat of snowy plovers is characterized by flat, open areas with sandy, saline, or alkaline substrates; vegetation is sparse or absent (Boyd 1972, Wilson 1980, Page et al. 1983, Warriner et al. 1986) (Fig. 2). The habitat is often considered unstable due to flooding associated with tidal inundation, fluctuating water levels, or storms and high winds that cause movement of the substrate (Wilson 1980, Stenzel et al. 1981). Encroachment of vegetation is probably suppressed by flooding, wind activity, or inability of plants to tolerate substrate conditions. The minimum extent (length or width) of an area necessary for use by breeding snowy plovers is unknown. The relatively consistent presence of birds on the coast at estuary or river mouths or at beaches where the foredune is breached, rather than along many stretches of dune- or bluff-backed beaches (Wilson 1980, Stenzel et al. 1981), suggests that the narrowness of some areas eliminates or reduces their use by snowy plovers.

Based on a classification system of beaches proposed by Stenzel et al. (1981) for the West coast (Table 4), snowy plovers primarily inhabit sand spits, dune-backed beaches, and open areas in estuaries during the breeding season (Widrig 1980, Wilson 1980, Stenzel et al. 1981). At interior sites they breed around margins of alkaline or saline lakes and ponds, or reservoirs (Boyd 1972, Page et al. 1983). Atypical habitats used for nesting include salt evaporators, levees associated with saline ponds, parking lots, dune systems up to 1 km (0.6 mile) from the beach, and dredged material (Page and Stenzel 1981; R. W. Jacobs, unpubl. data).

Beach types not used or infrequently used during the breeding season may show more use during the nonbreeding season (Page et al. 1981). Wintering

1

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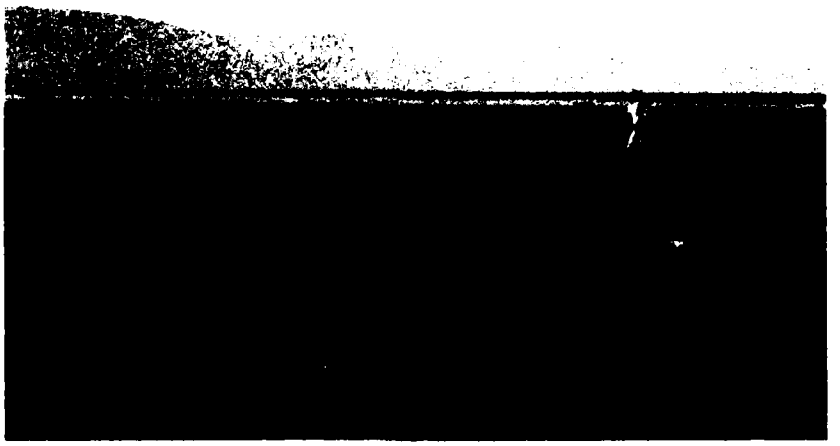


Figure 2. Habitat of snowy plovers (1) along the Oregon coast and (2) adjacent to an alkaline lake in south-central Oregon

Table 4. Classification of coastal beaches suggested by Stenzel et al. (1981)

Type	Description
Bluff-backed beach	Backed by cliffs, bluffs, or other nondune, nonwetland habitat.
Dune-backed beach	Backed by dunes; may be interrupted by a river, creek, pond, lagoon, or salt flat.
Small pocket beach*	Short beach at the mouth of a river, creek, or lagoon that is delimited and dominated by bluffs or rocky points.
Spit**	Sand spit or bar separating the ocean from a coastal wetland.
Estuarine margin	Disturbed or naturally open area in or at the margin of an estuary or a lagoon; often a salt flat.
Salt evaporator	Man-made habitat that includes low dikes, separating ponds, and floors of dried evaporators.

* Small pocket beaches are sometimes similar to spits but are distinguished by several characteristics. Because pocket beaches are short and usually span less than 1.5 km (0.9 mile) of coastline, they are almost always dominated by delimiting cliffs or bluffs. Significant vegetated dune or hummock development behind the beach is usually lacking.

** Spits may be delimited at either end by cliffs, bluffs, dunes, or lowlands; but because of their length and the presence of fairly extensive low wetlands behind them, they are not dominated by towering topographic features. Spits usually have well developed dune or hummock structures between the beach and the wetland.

birds on the West coast consistently select sand spits and dune-backed beaches for habitat (Page et al. 1981).

Food

The food habits and nutritional requirements of snowy plovers have not been studied in detail. Information in this section represents incidental observations of researchers while studying other aspects of the bird.

On coastal areas snowy plovers are known to feed on small marine invertebrates such as sand crabs (*Emerita analoga*), shore crabs (*Pachygrapsus* spp.), polychaetes, sand fleas (Orchestoidea), and miscellaneous insects including ephydrid (brine fly) larvae and buprestid, tenebrionid, and carabid

beetles; they also occasionally eat small fish (Reeder 1951; R. W. Jacobs, pers. observ.). Around alkaline and saline flats, they have been reported to eat ephydrids, staphylinid beetles, and miscellaneous insects blown onto the flats (Purdue 1976).

Water

The consistent association of snowy plovers with water is probably related to food supply. Snowy plovers apparently do not have exceptional ability to tolerate salt or reduced water turnover even though their habitats may have high ambient temperatures or highly saline water supplies. According to a controlled laboratory study (Purdue 1976), snowy plovers cannot maintain body weight when their drinking water contains levels of NaCl greater than 0.3 mole per liter. The daily water turnover (percent body weight per day) of birds at 25° to 40° C (77° to 104° F) is from 43% to 48%, a level similar to other avian species of similar body weight (Purdue 1976). Feeding on insects that have a high water content and adjusting behaviors to reduce water loss, such as standing in pools during hot weather (Purdue 1976) or concentrating near freshwater seeps (Grover 1979), may allow snowy plovers to tolerate saline or alkaline environments. Adequate or optimal distribution of water supplies is unknown.

Cover

Nests are often located on dry substrate adjacent to objects such as shells, wood, rocks, or general debris (Boyd 1972, Wilson 1980, Page et al. 1985). If cover associated with nests on the Oregon coast is typical, snowy plovers select an average of 26% cover within 1 sq m (10.8 sq ft) of the nest, a value higher than the average cover of the entire breeding area (11%) (Wilson 1980). Association of a nest with dense vegetation is rare, but chicks will use vegetation for escape cover (Page et al. 1981). Small and isolated clumps of vegetation covering less than 5 sq m (53.8 sq ft) may therefore be an important habitat component.

MANAGEMENT

Management Areas

An offshore island, sand spit, estuary margin, or any similar area could be managed for snowy plovers in coastal regions. Potential management sites at interior locations are alkaline or saline lake basins, salt flats

associated with a reservoir, or a system of sandbars along a river. The optimum size and dimensions of management areas for snowy plovers have not been determined, but the width of a site should normally be greater than 50 m (164 ft). Average slope should be near zero. Other features present should be as previously discussed for habitat components.

Management Practices

Specific management techniques have not been developed for snowy plovers. Practices discussed below involve primarily the maintenance and protection of suitable breeding habitat.

Cover manipulation. Cover conditions should be assessed on an annual basis. Procedures to reduce cover should be implemented whenever average cover exceeds 11% or average cover of live vegetation exceeds 1%. Vegetation will probably be the principal cover component in need of manipulation. The importance of vegetation control was suggested by Wilcox (1959) in his studies of the piping plover on the Atlantic coast. Wilcox noted an increase in number of nesting pairs following the breaching of a vegetated foredune by storm activity. As vegetation reestablished, there was a corresponding reduction in numbers of piping plovers.

On the Oregon coast, some snowy plovers nest on dredged material deposited on stands of European beachgrass (*Ammophila arenaria*) (Wilson 1980). Shell fragments on a sand substrate constitute the habitat (R. W. Jacobs, unpubl. data). Deposition of dredged material to control vegetation or increase extensiveness of habitat on areas with current or relatively recent use by snowy plovers may be a positive management practice. However, dredged material is not a preferred feeding area for adults (R. W. Jacobs, unpubl. data), and access to beaches or wetland margins for feeding by adults and unfledged chicks should be a necessary consideration in selection of disposal sites.

If the hypothesis is valid that narrow features of some areas reduce the extent of use by snowy plovers, inland extension of narrow coastal beach segments may result in increased use of some areas. Removal of the foredune and control of exotic grasses would be necessary to increase the width of coastal habitat.

Water. Where management for snowy plovers is a primary objective, natural freshwater inflows to alkaline or saline basins should not be reduced, nor should levels of ground water be allowed to fall to the extent that seeps

and springs dry artificially. There is the potential to increase use of lake beds in years of drought conditions by maintaining standing water in lake beds that would otherwise dry completely. Reservoirs, artificial ponds, or other water supplies controlled by man should not be full to the exclusion of nesting, and water levels should not be raised after the onset of nesting activities because of the possibility of flooding nests or drowning broods. To avoid potential damage to food supplies, levels of salinity and alkalinity of water supplies should not be drastically altered.

Human activities. The association of snowy plovers with water is often inconsistent with human activities and development. Degradation of coastal habitat of snowy plovers by urban, recreational, or industrial development (Stenzel et al. 1981) and reductions in numbers of nesting birds in the vicinity of reservoirs or ponds with high levels of water at the beginning of the breeding season (Boyd 1981a, b) are known. The introduction of vegetation to control the instability of coastal sand dunes is also suspected to be locally detrimental to snowy plovers (Wilson 1980).

Lowering water tables or diverting inflows of water to saline or alkaline basins may be detrimental to snowy plovers by reducing food supplies. Complete absence of water from a lake bed would prohibit nesting entirely. Diversion of inflows to lake beds may not result in a complete absence of standing water but may alter salinity and alkalinity levels to the extent that food supplies are reduced. The latter has been suggested as a possibility for Mono Lake, California, where most of the lake's natural inflow is diverted annually for human needs. Too much water also presents a problem for nesting birds because either insufficient habitat is available for nesting or nests and broods are flooded (Boyd 1981a).

Developments that would increase levels of human activity on breeding or wintering areas of snowy plovers should be controlled; examples of such developments include campgrounds, roads, and off-road vehicle corridors. As a means to reduce public access, breeding and wintering areas should be closed to off-road vehicle traffic. Where human activity patterns are established and the patterns potentially conflict with the presence of snowy plovers, the public should be informed of the presence and habits of the bird. Public education efforts that included placement of interpretive signs at access points to nesting areas and distribution of news releases prior to the nesting season were successfully used to eliminate human activity on nesting areas on

a portion of the Washington coast (Saul 1982). Figure 3 shows an interpretive sign used to help protect snowy plover nesting habitat in Oregon.

Monitoring success. The success of management practices can be judged by monitoring changes in the distribution and abundance patterns of snowy plovers over time (see following section). Because of low numbers of birds, at least 5 to 10 years of monitoring will probably be necessary to assess changes.

CENSUS AND SAMPLING

Habitat Variables

Food supply. Invertebrates are important in the diet of snowy plovers. Standard invertebrate sampling techniques, such as core sampling of substrate, may provide a measure of potentially available food items; however, data collected cannot accurately assess food supplies until detailed information on the food habits of snowy plovers is known. Therefore, it is not recommended that management personnel attempt to measure variables related to food supply.

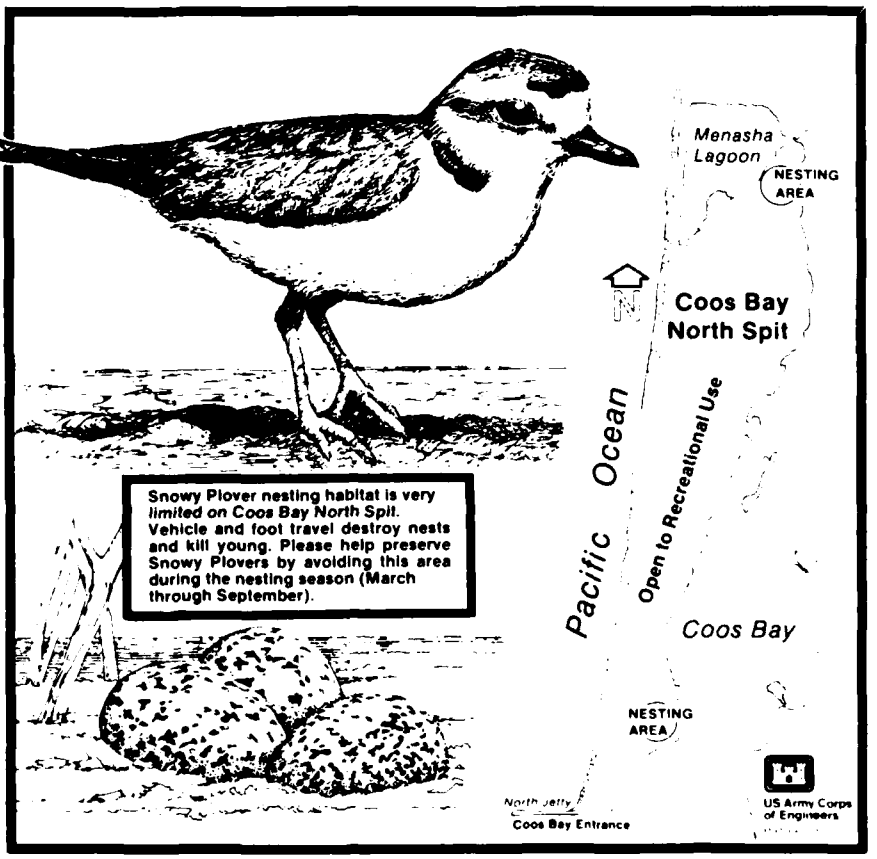
Cover. Line intercept sampling (Canfield 1941) was used successfully by Wilson (1980) to measure cover characteristics of snowy plover nest sites. The technique could also be successfully used to measure general cover features of feeding and roosting areas of breeding and nonbreeding snowy plovers. Cover characteristics should be recorded as bare substrate, vegetation (to species if possible), woody litter, leafy litter, shell, and miscellaneous debris. If line intercept sampling is used to sample cover of nest sites, transects should not radiate more than 10 m (32.8 ft) from a nest.

Population Estimates

Breeding bird surveys. Surveys for breeding snowy plovers should be conducted on foot in May and June by field personnel familiar with nesting behavior and plumage patterns of all age groups. Because of clumped distribution patterns, generally low numbers of birds, and difficulties with detection of individuals, a total area survey is more reliable than population sampling techniques such as Emlen transects (Emlen 1971) or variable circular-plot censusing (Reynolds et al. 1980). Correction factors for numbers of birds present but not counted during surveys are difficult to derive, and measures of abundance will invariably be relative. Exceptions may exist for intensively studied populations that occur within areas readily defined and easily surveyed.

Snowy Plover Nesting Area

Please Stay on Road When Passing Through This Area



For more information contact:

Coos Bay Field Office
Corps of Engineers
P.O. Box 604
North Bend, OR 97459
Phone (503) 267-6484

or

Oregon Department of Fish & Wildlife
P.O. Box 5430,
Charleston, OR 97420
Phone (503) 888-5515

Figure 3. Interpretive sign used to help protect snowy plover nesting habitat (courtesy USAE District, Portland, and USAE Division, North Pacific)

On broad expanses of habitat, multiple transects across the habitat should be traversed to ensure adequate coverage. Numbers of adults observed should be recorded by sex when possible and by type of area surveyed. The classification system proposed in Table 4 can be used to typify coastal beaches. In all places where snowy plovers occur, attempts should be made to document nesting based on the presence of nests or chicks or by adult behavior indicative of nesting activity. Numbers of adults observed per kilometer of coastline surveyed provide a good index to abundance on narrow coastal beaches where the size of an area fluctuates dramatically with the tidal cycle. Where suitable habitat is extensive, birds per hectare should be recorded. Because relative abundance or density of birds at an area may vary with physical conditions (notably, the presence of water), it may be appropriate to measure populations in concentric bands from a feature that influences distribution patterns. Measures of relative abundance or density of birds can be compared among areas or seasons using standard statistical tests such as Student's t-test or analysis of variance.

During all survey activities snowy plovers should be checked for leg bands to facilitate collection of information from active banding programs.* Color sequence from top to bottom, left or right leg, and position of the bands relative to the "knee" should be recorded (e.g., red band over white band, left leg, below "knee").

Surveys of nests and young. Nests, chicks, and juveniles cannot be detected as easily as adults. Thorough surveys at a minimum of weekly intervals are required to obtain nesting data. Nests can often be located by following tracks that radiate from a nest. Otherwise, observations of adult behavior may provide clues to the presence of nests or young. The average number of simultaneously active nests observed per week per area searched provides a relative measure of nest density. To estimate numbers of young fledged per breeding female, repeated observations of individually marked adults and broods are necessary. Because of the time required to color-band birds (the usual method of identification) and to detect broods, it is not recommended that management personnel attempt to measure reproductive success.

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* Report information on banded birds to Bird Banding Laboratory, Office of Migratory Bird Management, Laurel, MD 20811.

Winter surveys. Surveys of wintering populations of snowy plovers should be conducted from October through February. Procedures suggested for surveys of breeding adults are suitable; however, distinction of males and females is not possible.

Seasonal trends. To estimate seasonal changes in abundance of adults requires a minimum of weekly surveys of an area. Procedures described for surveys of breeding birds should be followed. Sample sizes will often be low, and variation among weekly counts may be high. At least 5 years of data collection will be necessary to identify trends.

Manpower and equipment. The principal investments in surveys of snowy plovers are manpower and mileage. On a strand of coastal beach, 1 person can conduct a survey; at extensive interior sites, 2 or more people are recommended, especially when multiple transects across the area are necessary. Under ideal conditions, 1 person on foot should be able to cover an area 5 km (3 miles) long and 100 m (0.06 mile) wide in 1 hour.

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